

Visit to Prof. Emil Sebastian Buecherl in Berlin, September 16, 1973

Professor Buecherl met us at the airport and took us to the Hotel Am Zoo. He picked us up later in the day to go to his home for cocktails, following which they took us out to dinner at the Schwabenwirt Restaurant. It was a very pleasant way of becoming better acquainted with both of them. On Monday morning, the 17th, I was picked up by Dr. Ewald Hennig, an engineer on the team and taken to the University Klinik and Poliklinik. Dr. Buecherl was replacing a mitral valve in a 38 year old man with a Bjork-Shiley pyrolytic carbon valve. His patterns of operating were precise and technically excellent as well as being expeditious. Those scrubbing with him were Drs. Keilbach, Clevert, and Weidemann, all of whom I met later. After the operation Dr. Buecherl and I went to his office and talked. He has been using the Lande-Edwards membrane oxygenator until recently, when he has had two patients who failed to wake up after operation. Apparently, without warning to the users, the Edwards Laboratory has used finely powdered sodium chloride or sodium carbonate to prevent the layers of the membrane oxygenator from sticking together during shipment. The amount of this sodium salt is uncontrolled. They have been able to wash as much as 25 grams of sodium salt out of a single oxygenator, or 50 grams out of the pair utilized for a clinical case. They are using the Travenol curtain bubble oxygenator for this reason.

The personnel involved besides those already mentioned included Dr. Krautzberger and a Dr. Kleine. Like Dr. Buecherl, all these other surgeons are paid by the Klinik, in addition to which they may take care of private patients. As far as the artificial heart is concerned, these men all work one day a week. The veterinarian, Mr. Grosse-Siestrup works full-time and is paid for it. The Klinik also hires and pays Dr. Klaus Affeld, an engineer, and Dr. Wallner, also an engineer, whom I did not meet. The remaining 19 persons in the team are paid for full-time work by the government. This includes dieners, mechanics, assistants, engineers, etc. Among the engineers, in addition to Dr. Ewald Hennig, were a Mr. Alex Mohnhaupt and a Mr. Reiner Mohnhaupt, his brother, a Dr. Unger, a Dr. Oh, a Mr. Kless, a Von Blumenthal and a Baer, whom I did not meet.

During our discussion, I noted that I did not see any cardiologists, biomchemists, or physiologists in the team. Prof. Buecherl indicated that he is hoping soon to be able to recruit a polymer chemist, a Dr. Berger from Israel. He is new to biology, but is expected to learn this aspect of it quickly. There is no hematologist. Dr. Buecherl indicated there were difficulties in recruitment. A law was passed in 1969 that any man who remains in academic life for five years and wants to be a professor can be made a professor. Being a professor entitles him to have his own department and crew. The department of Medicine there at the Free University of Berlin has 140 beds and 20 professors, only five of whom are really good enough to have that name. The government apparently is interested in spreading medical people out into many posts and positions, and on the part of the men concerned there is a tremendous drive to have their own departments. Thus it is very difficult to recruit anybody to join Prof. Buecherl, who is

a surgeon. They talk about wishing to cooperate but go off in another direction when a particular problem comes up, so that he is not able to hire a physiologist to join him. On the other hand, of the surgeons with him, five have had two or three years of physiology and four more have worked a year or more in experimental surgery.

I spent the rest of this day meeting with various members of the team. It became apparent that until recently a great deal of difficulty had been encountered in survival of calves, and the hemoglobin had been found to be very low at the end of the operative procedures. Upon testing the hemoglobins of calves before using them, it was learned that the hemoglobins run from four to six grams percent in 100 Kg. animals 80 days old. Cardiac outputs were ten or twelve liters per minute. (Normal is thirteen grams of hemoglobin and a cardiac output of six or seven liters per minute.) The difficulty was found to be the manner in which calves are raised for the meat industry in Germany. With a great interest in having the veal as white as possible, the calves are placed upon a synthetic diet containing virtually no iron and are kept in stalls and not permitted to run. They are ordinarily butchered at about 90 days. It was learned that if they were not butchered in 90 days they would die within another 20 days because of nutritional anemia. It is therefore necessary for Prof. Buecherl to obtain his calves shortly after birth and to raise them under the eye of his own veterinarian. This difficulty has delayed the whole program.

Dr. Hennig indicated that a calf of 80 days age costs between 650 and 800 Deutsch marks. This has been the cost since they started in February to buy newborns and to raise them themselves.

The laboratory is still getting blood for transfusion from the slaughter house. For some reason they do not seem yet to be very concerned about the fact that this blood is always contaminated.

I spoke with Dr. Oh, who has built a very excellent mock circulation system with the resistances, capacities, and variations of flexibilities of walls carefully patterned after those already predetermined in the animal. There are variable controls on peripheral resistance of both the pulmonary and the systemic circuits. Later on I observed Mr. Reiner Mohnhaupt during an experiment taking advantage of these controls. They are unique insofar as I know in that not only does each ventricle respond to Starling's law, but also pulmonary arterial pressure is utilized in an accessory fashion to control the output of the right ventricle as a means of extra protection of the lungs should there be any degree of failure of the left ventricle to respond to increased return.

The controls are much otherwise after the pattern of Kolff, with judgment as to adequacy of filling and emptying of each ventricle separately based upon the traces of the pneumatic drive pressure.

There is added to the control panel a separate tracing of gas velocity through these channels. The pump which has been developed is unique in another fashion, in that, although it has the general configuration of the Kolff ventricle, it is much better shaped to fit into the pericardium and in addition has the flexible internal membrane which is air driven of such dimensions that it cannot be distended enough to touch the outer casing unless the outer casing is compressed from outside. A major source of hemolysis, ulceration, and embolization is thereby avoided. They are using flocking of dacron upon a reinforced sylastic substrate, the method of attachment being that now causing trouble for TECO.

Dr. Hennig volunteered that they desperately need a hematologist, a bacteriologist, and a physiologist. They are now negotiating with the veterinary school so as to be able to get sterile blood from cows there. He volunteered that the recruitment of engineers is difficult because the university salary for them is from ten to twelve thousand dollars a year, a small fraction of what can be earned in industry.

I spoke some time with Dr. Affeld. He noted some hemodynamic difficulty in the device has been related to high flows. Much of this difficulty has been corrected by starting with properly prepared animals. In the second place, they are very much concerned about the materials being used. At the present time they are using a type of silicone rubber with dacron fibrils for flocking similar to Bernhard. They are concerned about transcutaneous leads, which they are ordering from Gulf in the U.S. with a design of their own. There is a skirt with big holes for better nourishment of the skin and anchorage of the lead. There is also a funnel-shaped skirt to which the surface layers of the skin are allowed to heal, thus providing flexibility and minimization of tensions that might interfere with healing.

Mr. R. Mohnhaupt exhibited a control console for the artificial heart which is run entirely fluidically with no electrical connections at all. This was regarded as potentially more reliable than the electronically activated console.

The manner of funding was discussed in some detail with Prof. Buecherl. From 1951 until 1967, his work was funded by the Deutsche Forschungsgesellschaft. In those years, Prof. Buecherl succeeded in getting some funding from the Ministry of Technology, and he has been funded from that source since that time. The total amount of his funding from the Deutsche Forschungsgesellschaft had amounted to approximately 1,700,000 Deutschmarks. At the present time this organization has forsaken Prof. Buecherl and supports a group called "Technological Applications for Vascular Diseases" in Aachen. This is headed by two engineers and has theoretical connection with a medical group at Dusseldorf, 300 kilometers away. The doctors there are working in a clinic which does only general surgical work, so that Prof. Buecherl is doubtful about the likelihood of their accomplishing very much in cardiovascular areas.

The new laboratory, building which is approximately half constructed at the present time, is being underwritten as a portion of the agreement for Prof. Buecherl to move to his present location some two years ago. The laboratory will enlarge the quarters and will require somewhat larger annual funding than he has enjoyed heretofore. Last year the Ministry provided him with one million Deutschmarks, and the clinic provided him with between three and four hundred thousand Deutschmarks. The Klinik also provides him with five academic positions for research so that the total amounts to approximately 1,600,000 Deutschmarks per year. He feels that with the new facility he will need approximately 2.2 million Deutschmarks per year and a bigger staff amounting to 35 to 38 people.

Buecherl himself has a full-time position at the University which pays around 4,000 Deutschmarks per month. His assistants are paid around 2,500 per month with an additional 1000 for being on emergency call as well. He is allowed to carry on private practice in addition to this. The insurance payments for private practice are generous. For instance, one case of esophageal resection paid 20,000 marks. The difficulty with this arrangement in Germany is that it has been abused. One professor in Dusseldorf has sixty private patient beds which he keeps busy around the year. He does no research work at all. Prof. Buecherl feels this is very bad for the reputation of academia. Buecherl himself has six or seven beds.

In general the support for research is most inadequate. For example in Lubeck, where there has been a university medical school since 1967 and where there are six or seven persons in the surgical department, only 15,000 marks per year are provided for research.

The primary difficulty is that the Ministry has made a big program for technological developments which are close to practical application, but not for the basic research necessary to make them possible. People in the Ministry surprised Buecherl by asking him how it happens that he needs so little money.

Within Prof. Buecherl's own group there was some difference of opinion as to the virtues of a central laboratory to carry out research on the artificial heart as against having various aspects of it handled in laboratories spread around the country. Dr. Hennig thought that the proper course is to have this work concentrated in one area so as to avoid wasted motion. Dr. Affeld on the other hand thought it would stifle the proper competition of imaginative minds to have everything under one person's control. The impression left by Prof. Buecherl was that it was his feeling that it was far more efficient to have everything done in one area.

Professor Buecherl and the visitor spent a considerable amount of time discussing patterns of management of a coordinated effort to create an artificial heart. He appeared to be keenly aware of the shortcomings

of attempts to establish a coordinated contractual pattern of development in the absence of a staff with sufficient breadth of expertise in direction of the overall effort to do so with thoroughness and understanding. He was fascinated with the concept of establishment of a prime contractor and asked many very searching questions with regard to the pattern in which this might be accomplished.

The hospital is part of the Free University of Berlin set up after World War II. The City Hospital is now the University Hospital. The group here is the only one in West Berlin performing open heart operations. Certain difficulties arise in the running of the program which are foreign to our experience in the United States. For instance, there is a group (Fachbereich), or commission, which controls the composition of the staff. There are fifteen members of which seven are professors, four are assistants, three are students, and one is a civil employee. Just recently Prof. Buecherl lost the best anesthetist he has had because the civil employee took a dislike to him and swung a majority against him. In spite of Prof. Buecherl's preference to have this man work with him he had to be dismissed.

The travel plans were changed to permit presence on September 20 at the implantation of an artificial heart to replace both ventricles on a calf. Although the facilities were in an old building and in the basement without builtin airconditioning, the organization of the experiment was superbly arranged. Items of interest included the following:

1. A V-shaped animal board which fits precisely on the table and holds the animal in a precisely dorsal position.
2. A crossbar built onto the table for the mounting of strain gauges and connections for transfusion and determination of cardiac output.
3. Lande-Edwards membrane oxygenators in parallel
4. A six channel recorder
5. A computerized recording printout system which prints out all automatically recorded data on a continuous flow sheet in the next room supplemented by a technician-secretary who types in special items as they are forwarded to her by walkie-talkie.
6. A separate display screen with control panels for the pneumatic pumps which Mr. Axel Mohnhaupt can view to have a continuing record of the degree of the filling of the ventricles and the degree of emptying, with correction when needed.
7. An in vivo oximeter which gives a continuous readout of blood oxygen saturation (Edwards Laboratories)

8. A volume monitored Bennett respirator

9. A catheter was placed in the bladder in this female calf. This is apparently routine.

The whole atmosphere and attitude were those of interest in making the procedure as smooth as possible for the fourteen people who were involved, including Prof. Buecherl. A suggestion from me as to how the connection of the respirator to the animal might be simplified drew immediate thanks and the careful making of notes about how to do it for the next procedure.

The surgical procedure proper was done in precise, technically correct fashion. The quick-connect devices were less easily manageable than those of TECO, but they were made to work. The group appeared not to be concerned that the blood pressure during the procedure was running between 40 and 60 millimeters of mercury or that the venous oxygen percent saturation for a time was running between 20 and 30 with a temperature of 34°. The artificial heart took over very nicely. Prof. Buecherl joined the scrub team at 12:05 and at 1:19 all connections had been made, and the artificial heart was carrying the circulation. Although no attempt has yet been made to synchronize to the atria and although there was no atrial fibrillation, the artificial heart developed a satisfactory cardiac output, and the animal's blood pressure gradually rose in the hour following completion to a normal level.

The calf was standing and eating by 6:00 p.m. on the day of operation. She was alert and responding to petting the following morning.

Prof. Buecherl told me when I saw him in Cleveland on October 20 that they had named the calf Dennis and that it survived six days.

Conclusions concerning visit:

There appeared to be no sound reason for reviewing the entire German program inasmuch as Dr. Lenfant and Dr. Harmison had done so approximately a year earlier. The conclusion was made that it would be more fruitful to concentrate on that one component of the program which appeared to be most advanced. Those items which were most striking were:

1. There was tremendous team spirit combined with enthusiasm and genuine accomplishment.
2. There was an obvious determination to learn everything possibly available concerning the work of others in the areas in which these people are working, a characteristic which would have been highly valuable in the U.S.'s program and which has been significantly absent on the part of many contractors.

3. Although the program is well supported, the organization of personnel is perplexing. Each and all of the medical members of the team work primarily as clinicians and give on an average one day a week to the project. More intense attention to this aspect of the problem might be fruitful.

4. The surgical and technical inputs into the program are of very high caliber. The group appears to have solved the problem of bringing conduits through the intact skin without advance of infection. On the other hand, there is painful absence of expertise in hematology, physiology, pathology, etc. This has hurt the program badly, for instance, in failure to recognize for a period of years the very severe anemia existing in the calves delivered to the laboratory. Even though a polymer chemist is being recruited, there appears to be no intention to bring in a hematologist as well. This difficulty is partly offset by physiologic experience on the part of several members of the surgical team.

5. In spite of these shortcomings, this German effort is highly likely to overtake that in the United States unless there can be established a far better pattern of supervision and coordination than that which has existed to date in the NHLI program.

P.S. As an addendum to the scientific report it is appropriate to indicate the very generous cordiality extended to the visitor and his wife by Prof. Buecherl and his associates (Prof. Emil Sebastian Buecherl, home address, 26 Wangenheimstrasse). Prof. Buecherl met us at the airport, took us to the hotel Am Zoo where he had made reservations for us, gave us time to get rested a bit, had us to his home to meet his family for cocktails and then took us out to dinner. The following evening we were guests at their home for dinner. On Tuesday evening we met Prof. Buecherl at his downtown office in Europa Center to see the city from that vantage point and have a cocktail before going to the ballet at the West German Opera House. In addition to these gestures, Prof. Buecherl sent a beautiful bouquet of flowers to the hotel room. On Wednesday evening the Dennises served as host and hostess to Prof. Buecherl and his wife (a certified anesthesiologist) at the Restuarant Ambassador.

Clarence Dennis, M.D., Ph.D.

October 24, 1973